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British Standard Institution
Report

No. 24—1911. (PART IV.).

British Engineering Standards Association.

(*Incorporated 1918.*)

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE

BY

THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

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BRITISH STANDARD SPECIFICATIONS FOR

RAILWAY ROLLING STOCK MATERIAL.

PART IV.

STEEL FORGINGS, BLOOMS AND CASTINGS.

(REVISED DECEMBER, 1911.)

LONDON
PUBLISHED FOR THE ASSOCIATION BY CROSBY LOCKWOOD & SON,
7, STATIONERS' HALL COURT, LUDGATE HILL, E.C. 4; AND 5, BROADWAY, LONDON, S.W. 1,
AND TO BE PURCHASED FROM ANY BOOKSELLER, OR DIRECT FROM THE OFFICES OF THE ASSOCIATION,
28, VICTORIA STREET, LONDON, S.W.

November, 1918.

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BRITISH ENGINEERING STANDARDS ASSOCIATION.

MAIN COMMITTEE.

†SIR ARCHIBALD DENNY, BART. (*Chairman*).

SIR MAURICE FITZMAURICE, C.M.G. (*Vice-Chairman*).

SIR WILLIAM MATTHEWS, K.C.M.G.	Nominated by the Institution of Civil Engineers.
SIR DOUGLAS FOX	
MR. R. ELLIOTT-COOPER	
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MR. H. A. IVATT	Nominated by the Institution of Mechanical Engineers.
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MR. G. AINSWORTH	Nominated by the Iron and Steel Institute.
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SIR WILLIAM SMITH, C.B.	
COL. R. E. CROMPTON, C.B.	Nominated by the Institution of Electrical Engineers.
SIR JOHN SNELL	
MR. C. P. SPARKS	
MR. F. R. DAVENPORT	Co-opted by the Nominated Members to represent the Federation of British Industries.
MR. F. W. GILBERTSON	
HON. SIR CHARLES PARSONS, K.C.B.	Co-opted by the Nominated Members.
SIR ROBERT HADFIELD, BART.	
SIR RICHARD GLAZEBROOK, C.B.	

DR. J. H. T. TUDSBERY (*Hon. Secretary*).

MR. C. LE MAISTRE (*Secretary*).

MR. CHARLES DRESSER (*Assistant Secretary*).

---

† Succeeded the late SIR JOHN WOLFE BARRY, K.C.B., February, 1918.

BRITISH ENGINEERING STANDARDS ASSOCIATION.

The following are lists of the Members of the Sectional Committee on Locomotives and its Sub-Committees, and of the Sectional Committee on Railway Rolling Stock Underframes.

SECTIONAL COMMITTEE ON LOCOMOTIVES.

December, 1911.

Chairman, SIR DOUGLAS FOX.

War Office, *Major A. G. Stevenson, D.S.O., R.E.

India Office, Mr. A. Brereton, C.S.I.

Crown Agents for the Colonies, Mr. G. L. Eyles, C.M.G.; Mr. Ashton M. Heath.

Locomotive Manufacturers' Parliamentary Association: Mr. W. Lorimer (*North British Locomotive Co., Ltd.*); †Mr. Hugh Reid (*North British Locomotive Co., Ltd.*); **Mr. T. P. Reay (*Kitson & Co., Ltd.*).

Railway Companies' Association: Mr. J. A. F. Aspinall (*Lancashire and Yorkshire Railway*); Mr. J. F. McIntosh, M.V.O. (*Caledonian Railway*).

Association of Railway Locomotive Engineers: Mr. G. J. Churchward (*Great Western Railway*); ‡Mr. G. H. Hughes (*Lancashire and Yorkshire Railway*).

Steel Ingot Makers' Association: §Mr. Maxmilian Mannaberg (*Frodingham Iron and Steel Co., Ltd.*).

Steel Founders' Association of Great Britain: Sir Robert Hadfield (*Hadfield's Steel Foundry Co., Ltd.*).

Mr. F. Wolley-Dod (*Chairman of the Calcutta Conference, 1901*).

**Sir John Wolfe Barry, K.C.B.; Mr. G. Ainsworth (*Consett Iron Co., Ltd.*); **Mr. H. C. Arbuthnott (*Taylor Bros. & Co., Ltd.*); Mr. J. Hartley Bibby (*John Bibby, Sons & Co.*); Mr. D. Cassels (*Steel Company of Scotland, Ltd.*); Mr. W. Collingwood (*Vulcan Foundry, Ltd.*); Mr. J. M. Dobson (*Hawkshaw & Dobson*); ‖Mr. J. Duncan Elliot (*Carruthers & Elliot*); Mr. F. C. Fairholme (*Thomas Firth & Sons, Ltd.*); Mr. C. N. Goodall (*Robert Stephenson & Co., Ltd.*); Mr. E. Greg, Jnr. (*Nasmyth, Wilson & Co., Ltd.*); Mr. Cyril Hitchcock (*Sir George Bruce & White*); ¶Mr. A. F. Halstead (*Beyer, Peacock & Co., Ltd.*); Mr. Bradford Leslie (*A. J. Barry & Leslie*); Mr. Edward Mills (*Williams, Foster & Co.*, and *Pascoe, Grenfell & Sons, Ltd.*); **Mr. F. E. Robertson, C.I.E. (*Rendel & Robertson*); Mr. Frederick Tomlinson (*Broughton Copper Co., Ltd.*); Mr. Seymour B. Tritton (*Rendel & Robertson*); Mr. J. N. Vickers (*Vickers, Ltd.*); Mr. Robert White (*Sir George Bruce & White*).

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* Succeeded Major T. H. Cochrane, M.V.O., R.E., October, 1909.

† Succeeded Mr. J. F. Robinson, January, 1910.

‡ Succeeded Mr. James Holden, June, 1908.

§ Succeeded Mr. F. W. Dick, July, 1909.

‖ Succeeded Mr. John Carruthers, July, 1910.

¶ Succeeded Mr. A. S. Jameson, June, 1911.

** Deceased.

SECTIONAL COMMITTEE ON RAILWAY ROLLING STOCK UNDERFRAMES.

December, 1911.

Chairman, SIR DOUGLAS FOX.

Crown Agents for the Colonies, Mr. G. L. Eyles, C.M.G. ; Mr. Ashton M. Heath.

Mr. D. Bain (*Midland Railway*) ; Mr. Lincoln Chandler (*Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd.*) ; Mr. Thomas G. Clayton (*late Midland Railway*) ; Mr. Brodie Henderson (*Livesey, Son & Henderson*) ; †Mr. G. A. Hobson (*Sir Douglas Fox & Partners*) ; *Mr. H. D. Earl (*London & North Western Railway*) ; †Mr. F. E. Robertson, C.I.E. (*Rendel & Robertson*) ; Mr. H. J. Skelton (*H. J. Skelton & Co.*).

* Succeeded Mr. C. A. Park, June, 1910.

† Deceased.

LOCOMOTIVE SUB-COMMITTEES.

December, 1911.

SUB-COMMITTEE ON TYRES, AXLES AND SPRINGS.

Chairman, Mr. G. J. Churchward.

†Mr. H. C. Arbuthnott ; Mr. W. J. Armitage ; Mr. D. Bain ; Mr. Lincoln Chandler ; Mr. F. C. Fairholme ; Mr. Albert Good ; Mr. Richard Halstead ; Mr. Ashton M. Heath ; Mr. C. Hitchcock ; Mr. Henry Steel, Jnr. ; Dr. W. C. Unwin.

SUB-COMMITTEE ON LOCOMOTIVE STEEL PLATES.

Chairman, Mr. W. Lorimer.

Mr. G. Ainsworth ; Mr. D. Cassels ; Mr. Maxmilian Mannaberg ; †Mr. T. P. Reay ; Dr. W. C. Unwin.

SUB-COMMITTEE ON COPPER AND ITS ALLOYS.

Chairman, Mr. J. F. McIntosh, M.V.O.

Mr. J. Hartley Bibby ; Mr. Edward Mills ; Mr. Hugh Reid ; Mr. Frederick Tomlinson.

† Deceased.

PREFACE TO FIRST EDITION.

The subject of the Standardisation of Locomotives was first raised at a meeting of the Main Committee on January 14th, 1902, when Sir John Wolfe Barry recorded interviews he had had with Lord George Hamilton and other officials of the India Office with regard to this subject, and it was agreed that evidence should be collected. On March 4th, 1902, the Main Committee sat to hear evidence on the subject, and this being in favour of proceeding, a Sectional Committee on Locomotives was formed under the Chairmanship of Sir Douglas Fox.

The Sectional Committee on Locomotives held their first meeting on May 30th, 1902, when the following Sub-Committees were formed :—

Name.	*Chairman.*
Locomotive Steel Plates . .	Mr. W. Lorimer.
Tyres, Axles, and Springs . .	Mr. W. Lorimer.
Copper and its Alloys . .	Mr. W. Dean. (Succeeded by Mr. J. F. McIntosh).

A number of meetings of the Sub-Committees have been held, and the Report in its present form was adopted by the Sectional Committee on Locomotives at their meeting held on March 23rd, 1906.

The Sectional Committee on Locomotives desire to place on record their appreciation of the services rendered by the Association of Railway Locomotive Engineers through their representatives on the Committee.

In many instances, somewhat divergent opinions have had to be reconciled, and this has only been rendered possible by accepting the view that the Standard Specifications will be considered from time to time as occasion requires, and the Sectional Committee are desirous of making this point clear when submitting their Report.

To meet the various needs of the Home, Indian, and Colonial requirements, the Committee have in many cases included similar Specifications—one with, and the other without, a Chemical Analysis—in order that those who do not desire to specify a Chemical Analysis can still use a Standard Specification.

The Sectional Committee on Railway Rolling Stock Underframes, under the same Chairman, was appointed by the Main Committee at their meeting on July 16th, 1901. Having, in conjunction with the Sectional Committee on Sections used in Shipbuilding and that on Bridges and General Building Construction, completed the drawing up of a list of Standard Sections, the preparation of a Standard Specification was proceeded with. For convenience of publishing, this Specification is included in the present volume, and constitutes Specification No. 17*.

The Specifications were considered by the Sectional Committee on Underframes at a meeting held in conjunction with the Sectional Committee on Locomotives on March 23rd, 1906, and finally adopted by the Sectional Committee on Locomotives at their meeting held on July 12th, 1906.

The Reports of the two Sectional Committees, which are contained in the present volume, were approved by the Main Committee at the meeting held on July 26th, 1906.

DOUGLAS FOX,

Chairman of the Sectional Committees on Locomotives and Railway Rolling Stock Underframes.

PREFACE TO SECOND EDITION.

Since the issue of the first revision in June, 1907, the Committees on Locomotives and Railway Rolling Stock Underframes have from time to time had brought before them points which have arisen in connection with the use of the Standard Specifications, and the present issue of Report No. 24 embodies the Committee's decisions in regard to these. Some of the more important modifications to the Specifications are as follows :—

1. The prohibition of a re-test in the case of failure under the falling weight test for Axles.
2. The option of a bend test in the Specification for Carriage and Wagon Axles (without analysis) if there is any question in the mind of the Engineer as to the Axle having satisfactorily passed the falling weight test.
3. The deletion of the Specification (without analysis) for Locomotive Tyres.
4. The deletion of Class **B** tyres (42-48 tons per square inch) from the Specification (with Analysis) for Locomotive Tyres.
5. The addition of Class **C** tyres (50-55 tons per square inch) to the Specification (without Analysis) for Carriage and Wagon Tyres.

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* Now published in Part VI. of Report No. 24—1911.

6. The deletion of Class **A** tyres (35-40 tons per square inch) from the Specification (without Analysis) for Carriage and Wagon Tyres.

7. The insertion in the Tyre Specifications of a formula for the deflection under the falling weight test based upon the thickness and internal diameter of the tyre in place of that previously employed which was based upon the internal diameter only.

8. The division of the Specifications for Laminated Springs and Spring Steel into separate Specifications, dealing respectively with Spring Steel and with the finished Springs.

   With a view of restricting the tensile stress on the plates of the finished Spring under the scragging test to a figure somewhat below 70 tons per square inch, a definite deflection, depending upon the length of the top plate of the Spring and thickness of the thickest plate, is now specified, and a table of the required deflections is inserted in the Specification.

9. The addition of a further class of Forgings (Class **E**) to the Forging Specification.

10. The reduction of the tensile strength of Rivet Bars to 24-28 tons per square inch.

The Committee have had representations made to them with regard to the use of the term "*Elastic Limit*" in the Axle and Forging Specifications, and this term has now been altered to "*Yield Point*," a definition of this latter term being added as a note to the Specifications in which this term is employed.

The Committee recommend that in specifying materials to any of the Specifications contained in this Report, both the Specification number and the number of the Report be quoted, in order to obviate confusion with other Reports of the Committee.

The Report in its present form was approved by the Sectional Committees concerned in October, 1911, and by the Main Committee on December 6th, 1911.

DOUGLAS FOX,

Chairman of the Sectional Committees on Locomotives
and Railway Rolling Stock Underframes.

Reference to be quoted.

Report No.	**24**
Specification No. 8-1911	

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
STEEL FORGINGS FOR LOCOMOTIVES.

(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Forgings shall be manufactured from Steel made by the Acid or Basic Open Hearth process as specified in Clause 4.

Freedom from Defects.

2. The Forgings must be free from defects of any kind and accurately finished to the prescribed dimensions.

Mechanical Tests.

3. Extra Forgings for testing, in the manner described in Clauses 4 and 5, shall be provided by the Manufacturer, at his own expense, at the rate of 2 per cent. of the Forgings ordered under the Contract, but at least one tensile or one bend test shall be taken from each cast. The representative of the Engineer (or of the Purchaser) shall select and test such of the Forgings as he may think proper to the extent of such percentage or number. The Forgings tested shall be held to represent correctly the quality of the casts from which they are made. When the number of Forgings ordered is less than 50, the Manufacturer must either (1) provide an extra Forging for testing, or (2) leave on each Forging a piece of not less sectional dimensions than the body of the Forging from which test pieces shall be taken.

Tensile Tests.

4. A Standard Test Piece **C** or **D** (*see* Appendix, page 25), machined cold lengthwise from each Forging selected as above, must, without further re-heating or any other manipulation whatever, show the tensile breaking strength and minimum elongation given in the Table, or all the Forgings represented by the test will be rejected.

Class.	Description of Forging.	Process of Manufacture.	Percentage of Sulphur or of Phosphorus.	Tensile Breaking Strength in tons per square inch.	Minimum Elongation per cent.
A	Special Forgings which will be case-hardened.	Acid or Basic Open Hearth	0·05	Up to 27 tons.	25
B	Ordinary Forgings.	Do.	0·06	25 with to 32 with	27 20
C	Special Forgings without wearing surfaces.	Acid Open Hearth.	0·035	32 with to 37 with	25 20
D	Special Forgings with wearing surfaces.	Do.	0·035	40 with to 45 with	20 15
E	Boiler Forgings.	Do.	0·05	26 with to 32 with	28 22

The sums of the tensile breaking strengths and corresponding elongations must be not less than 52 for Classes **A** and **B**, 57 for Class **C**, 60 for Class **D**, and not less than 54 for Class **E**. In the case of Classes **C** and **D** the yield point* must be not less than 50 per cent. of the ultimate tensile strength.

Cold Bend Test.

5. A test piece, 9 inches long and $1\frac{1}{4}$ inches square, or as near this size as the Forging or Forgings selected will permit, with $\frac{1}{16}$ inch radius at the edges, machined cold, must, without any re-heating, withstand being bent cold through an angle of 90 degrees round a bar $2\frac{1}{2}$ inches diameter, and the test continued, after the bar is removed, by the ends being brought together without fracture. In the case of Class **D** the test shall be continued, after the bar is removed, only until the sides are parallel.

Re-heating or Oil-treating.

6. All Forgings in Classes **C** and **D** shall be either re-heated or oil-treated.

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* The yield point shall for the purpose of this Specification be the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

Additional Tests before Rejection.

7. In the event of the Forging or Forgings selected for testing not satisfying the requirements of Clauses 4 or 5, and the fractured test piece indicating that the result does not fairly represent the bulk of the Forgings, the representative of the Engineer (or of the Purchaser) may at his discretion, and at the expense of the Manufacturer, take two more test pieces from Forgings from the same cast for repeating the test under which failure occurred. The Forgings will be accepted if the result of the repeat tests are satisfactory.

Inspection.

8. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this Specification.

Testing Facilities.

9. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No.	**24**
Specification No.	**9-1911**

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
STEEL BLOOMS FOR LOCOMOTIVE FORGINGS.

(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Blooms shall be manufactured from Steel made by the Acid or Basic Open Hearth process as specified in Clause 4, and must not show on analysis more than the percentages of Sulphur or of Phosphorus therein set forth.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

2. The Blooms must be free from defects of any kind.

Mechanical Tests.

3. One Bloom from each cast, for the Forgings covered by this Specification, shall be tested at the works of the Manufacturer as follows :—Test pieces shall be taken from a section drawn down in the presence of the representative of the Engineer (or of the Purchaser) to represent an average section of the Forgings to be made from such Blooms, and shall be tested in accordance with Clauses 4 and 5. If the results are satisfactory, the Blooms represented shall be accepted.

Tensile Tests.

4. A Standard Test Piece **C** or **D** (*see* Appendix, page 25), machined cold lengthwise from the drawn-down material selected as above, must, without re heating or any other manipulation whatever, show the tensile breaking strength and minimum elongation given in the Table, or all the Blooms represented by the test will be rejected.

Class.	Purpose for which required.	Process of Manufacture.	Percentage of Sulphur or of Phosphorus.	Tensile Breaking Strength in tons per square inch.	Minimum Elongation per cent.
A	Special Forgings which will be case-hardened.	Acid or Basic Open Hearth.	0·05	Up to 27 tons.	25
B	Ordinary Forgings.	Do.	0·06	25 with to 32 with	27 20
C	Special Forgings without wearing surfaces.	Acid Open Hearth.	0·035	32 with to 37 with	25 20
D	Special Forgings with wearing surfaces.	Do.	0·035	40 with to 45 with	20 15
E	Boiler Forgings.	Do.	0·05	26 with to 32 with	28 22

The sums of the tensile breaking strengths and corresponding elongations must be not less than 52 for Classes **A** and **B,** 57 for Class **C,** 60 for Class **D,** and not less than 54 for Class **E.** In the case of Classes **C** and **D** the yield point* must be not less than 50 per cent. of the ultimate tensile strength.

Cold Bend Test.

5. A test piece, 9 inches long and $1\frac{1}{4}$ inches square, with $\frac{1}{16}$ inch radius at the edges, machined cold, must, without any re-heating, withstand being bent cold through an angle of 90 degrees round a bar $2\frac{1}{2}$ inches diameter, and the test continued, after the bar is removed, by the ends being brought together without fracture. In the case of Class **D** the test shall only be continued, after the bar is removed, until the sides are parallel.

Additional Tests before Rejection.

6. In the event of the Bloom selected for testing not satisfying the requirements of Clauses 4 and 5, and the fractured test piece indicating that the result does not fairly represent the bulk of the

---

* The yield point shall for the purpose of this Specification be the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

Blooms, the representative of the Engineer (or of the Purchaser) may at his discretion, and at the expense of the Manufacturer, take two more test pieces as in Clause 3 from the same Bloom for repeating the test under which failure occurred. The Blooms will be accepted if the results of the repeat tests are satisfactory.

Inspection.

7. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times; he shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this Specification.

Testing Facilities.

8. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No.	**24**
Specification No.	**10-1911**

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
STEEL CASTINGS.

(REVISED DECEMBER, 1911.)

Quality of Material.

1. The Castings shall be manufactured from Steel produced by an approved process, and must not show on analysis more than 0·07 per cent. of Sulphur or of Phosphorus.

The Manufacturer shall supply an analysis of each cast when required to do so.

Annealing.

2. All Castings shall be thoroughly annealed in a suitable furnace before testing.

Moulding.

3. The Castings shall be accurately moulded in accordance with the pattern or working drawing supplied by the Engineer (or by the Purchaser), with the addition of such lettering as may be prescribed.

Branding.

4. The cast number shall be stamped upon each Casting, close to the moulded number of pattern.

Repairs to Defective Castings.

5. Any defects or unsound metal which a Casting may have, from whatever cause arising, shall be left bare, and no filling with the object of obliterating such defects will be permitted unless previously sanctioned by the representative of the Engineer (or of the Purchaser). Any Castings upon which such work has been done without such sanction having been obtained will be rejected.

Selection of Test Pieces.

6. The representative of the Engineer (or of the Purchaser) will examine all castings before delivery, and make a selection from the bulk of Castings from which the specified tests are to be taken. He will select and stamp pieces for testing purposes, to be cut from the Casting, or from lumps formed on each Casting, of such size and in such a position in the mould as will furnish test pieces which shall be truly representative of the remainder of the metal.

Number of Tests.

7. The Castings will be required to pass the tests specified below according to classification. The class of Castings shall be specified on the drawing.

Class **A. General Castings.**—One tensile and one bend test shall be taken from each cast, and two per cent. of the Castings shall be selected by the representative of the Engineer (or of the Purchaser) from the bulk, to be tested to destruction.

In the case of less than 50 Castings being ordered, one extra Casting shall, when so specified in the enquiry, be provided by the Manufacturer at his own expense for the destruction test.

Class **B. Wheel Centres.**—One tensile test shall be taken from each cast, and one bend test from each Wheel Centre, but in the case of Wagon Wheel Centres one tensile test and one bend test shall be taken from each cast. When a destruction test is specified the number of Wheel Centres selected to undergo this test shall not exceed 2 per cent.

In the case of less than 50 Wheel Centres being ordered, one extra Wheel Centre shall, when so specified with the enquiry, be provided by the Manufacturer at his own expense for the destruction test.

Class **C. Large or Important Castings.**—One tensile test shall be taken from each cast, and one bend test from each Casting.

Tensile Test.

8. A Standard Test Piece **D** having a gauge length of 3 inches and a sectional area of $\frac{1}{2}$ square inch (*see* Appendix, page 25), or failing a 3 inch test piece, a Standard Test Piece **C** having a gauge length of 2 inches and a sectional area of $\frac{1}{4}$ square inch (*see* Appendix, page 25), must, without re-heating or any other manipulation whatever, show not less than the minimum tensile breaking strength and elongation given in the Table.

Description of Casting.	Minimum Tensile Breaking Strength per square inch.	Minimum Elongation per cent.
Castings with wearing surfaces ...	35 tons.	10
Other General Castings and Wheel Centres	26 tons	15

Cold Bend Test.

9. In the case of Castings other than those with wearing surfaces, a test piece 9 inches long, turned to 1 inch diameter, must withstand being bent cold through an angle of 90 degrees round a bar 2½ inches diameter without fracture.

Drop Test.

10. Each Wheel Centre must withstand, without showing crack or flaw, being dropped on to a block of metal of not less than 5 tons weight supported on a rigid concrete or other solid foundation. The Wheel Centre shall be raised and allowed to fall freely in a running position from a height of 3 feet on the end of a spoke (where such exists). In the case of Wheel Centres cast with balance weights the height may be reduced to 2 feet.

Ringing Test.

11. Each Wheel Centre shall be suspended in a suitable position and struck with a quarter hammer on the rim and spokes (where such exist), and an examination made for any signs and blow holes or other defects.

Destruction Test.

12. When Wheel Centres are tested to destruction, the test shall be made by dropping the Wheel Centre on to a block of metal of not less than 5 tons weight supported upon a rigid concrete or other solid foundation. The Wheel Centre shall be raised and allowed to fall freely in a running position through distances of 5 feet and 10 feet on the end of a spoke (where such exists) and then turned through 90 degrees and again raised and allowed to fall freely in a running position through distances of 5 feet and 10 feet on the end of a spoke (where such exists). Any sign of failure under this test will render the Wheel Centres represented liable to rejection. The test shall then be continued, the fall being increased 5 feet each time until fracture results or the Wheel Centre is doubled up.

Additional Tests before Rejection.

13. In the event of the Casting selected for testing not satisfying the requirements of Clauses 8, 9, and 12, the representative of the Engineer (or of the Purchaser) shall, as specified below, make further tests of Castings, provided by the Manufacturer at his own expense, before finally refusing or accepting the Castings represented.

(*a*) **Tensile or Bend Test :**—Should the Casting fail in the tensile or bend test, and the fractured test piece indicate that the result does not fairly represent the bulk of the Castings, then in Castings coming under :—

Class **A.**—The tensile or bend test shall be repeated from pieces cut from the same lump.

The Castings shall be accepted if this second test is satisfactory, and the whole upon close examination found free from defects.

Class **B.**—Tensile test pieces shall be taken from two more Wheel Centres from the same cast or two more bend tests shall be taken from pieces cut from the same lump.

The Wheel Centres shall be accepted if two of the three test results are satisfactory, and the whole upon close examination found free from defects.

Class **C.**—Tensile test pieces shall be taken from two more Castings from the same cast or two more bend tests shall be taken from pieces cut from the same lump.

The Castings shall be accepted if two of the three test results are satisfactory, and the whole upon close examination found free from defects.

(*b*) **Destruction Test:**—Should the Wheel Centre fail in the destruction test before enduring the first four blows, and the fracture indicate that the result does not fairly represent the bulk, then two more Wheel Centres shall be taken for testing, one from the same cast and the second from another cast. The Wheel Centres shall be accepted if two of the three test results are satisfactory.

Inspection.

14. The representative of the Engineer (or of the Purchaser) shall have free access to the works of the Manufacturer at all reasonable times during the course of manufacture of the Castings; he shall be at liberty to inspect the manufacture at any stage, and to reject any Casting or material that is unsound or does not otherwise conform to the terms of this Specification.

Testing Facilities.

15. The Manufacturer shall supply the Castings, required under Clause 7 for testing, free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for making all tests on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Conversion Table.

Tons.	Pounds.	Tons.	Pounds.
17	38,080	44	98,560
18	40,320	45	100,800
19	42,560	46	103,040
20	44,800	47	105,280
21	47,040	48	107,520
22	49,280	49	109,760
23	51,520	50	112,000
24	53,760	51	114,240
25	56,000	52	116,480
26	58,240	53	118,720
27	60,480	54	120,960
28	62,720	55	123,200
29	64,960	56	125,440
30	67,200	57	127,680
31	69,440	58	129,920
32	71,680	59	132,160
33	73,920	60	134,400
34	76,160	61	136,640
35	78,400	62	138,880
36	80,640	63	141.120
37	82,880	64	143,360
38	85,120	65	145,600
39	87,360	66	147,840
40	89,600	67	150,080
41	91,840	68	152,320
42	94,080	69	154,560
43	96,320	70	156,800

NOTE.—1 Ton = 2,240 lbs.

APPENDIX.

FORMS

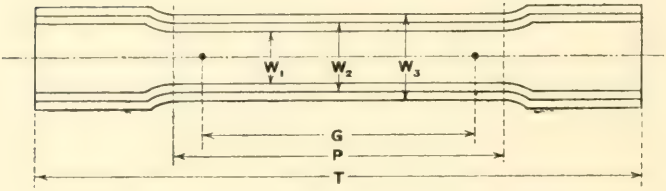
OF

BRITISH STANDARD TENSILE TEST PIECES.

APPENDIX.

FORMS
OF
BRITISH STANDARD TENSILE TEST PIECES.

TEST PIECE **A.**

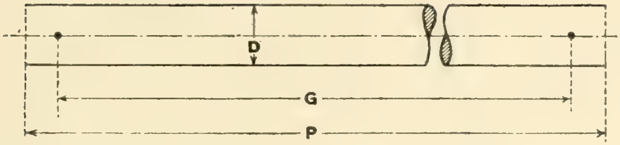


Gauge Length **G** = 8 inches.
Parallel Length **P** to be not less than 9 inches.
Total Length **T** = About 18 inches.

Thickness of Test Piece.	Maximum Width allowed.
Over $\frac{7}{8}$ in. (0·875 in.).	$W_1 = 1\frac{1}{2}$ ins.
$\frac{3}{8}$ in. (0·375 in.) to $\frac{7}{8}$ in. (0·875 in.).	$W_2 = 2$ ins.
Under $\frac{3}{8}$ in. (0·375 in.).	$W_3 = 2\frac{1}{2}$ ins.

The widths of the test pieces for plates were selected to comply with the two following conditions. (1) As the great bulk of plates to be tested are from $\frac{3}{8}$ inch to $\frac{7}{8}$ inch thick, it was desirable for the sake of convenience that the test pieces for such plates should be of uniform width, and, in accordance with very general practice, a width of 2 inches was selected. (2) With a test piece of a given form, the percentage of elongation was found to be less for thick plates than for thin ones; with steel of the same quality in other respects it was desirable therefore to choose widths of test piece which would be slightly in favour of the thicker plates. This is secured with the widths selected for the Standard Test piece of form **A.**

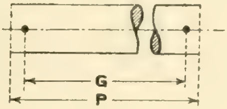
TEST PIECE **B.**



Gauge Length **G** to be not less than 8 times the diameter **D.**
With enlarged ends:—Parallel Length **P** to be not less
than 9 times the reduced diameter **D.**

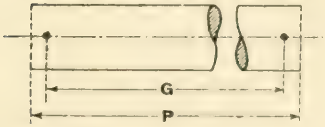
All test pieces of form **B** are strictly similar, and for the same material give the same percentage of elongation. They are nearly similar to a test piece of form **A,** 8 inches in gauge length, 2 inches wide and ⅜ inch thick.

TEST PIECE **C.**



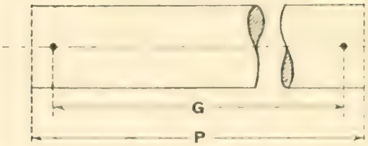
Gauge Length **G** = 2 inches.
Parallel Length **P** to be not less than 2¼ inches.
Dia. = 0·564 inch.
Area = ¼ sq. inch.

TEST PIECE **D.**



Gauge Length **G** = 3 inches.
Parallel Length **P** to be not less than 3⅜ inches.
Dia. = 0·798 inch.
Area = ½ sq. inch.

TEST PIECE **E.**

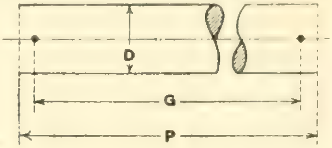


Gauge Length **G** = $3\frac{1}{2}$ inches.
Parallel Length **P** to be not less than 4 inches.
Dia. = 0·977 inch.
Area = $\frac{3}{4}$ sq. inch.

Test pieces **C, D,** and **E** were arranged to meet the very common practice of making test pieces for forgings, axles, tyres, etc., of either $\frac{1}{4}$ square inch or $\frac{1}{2}$ square inch in sectional area. With the gauge lengths decided upon, these three forms are very nearly similar, and, for a given material, give very approximately the same percentage of elongation. Though not exactly, they are approximately similar to the Standard Test piece **F,** and for the same material give a nearly identical, but slightly greater, percentage of elongation.

TEST PIECE **F.**

(For Test Pieces over 1 inch diameter.)



Gauge Length **G** to be not less than 4 times the diameter **D**.
With enlarged ends :—Parallel Length **P** to be not less than $4\frac{1}{2}$ times the reduced diameter **D**

In some testing machines it was found inconvenient to use form **B** for bars of over 1 inch in diameter, and form **F** of half the gauge length is designed to meet such cases. For a given material the percentage of elongation with test piece **F** is greater than with test piece **B,** and this difference is provided for in the British Standard Specifications.

FORM OF ENDS.

In the case of the round test pieces **B, C, D, E** and **F,** the form of the ends is to be as required in order to suit the various methods employed for gripping the test piece. When enlarged ends are used the length of the parallel portion of the test piece must in no case be less than that noted on the diagrams.

British Engineering Standards Association.

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OF
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NOVEMBER, 1919.

(This List cancels all previous Lists.)

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